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Dampness Problem in Dwellings at Tianjin and Its Association with Asthma and Allergy among Children

Yuexia Sun[a], Jing Hou[a], Pan Wang[a], Qingnan Zhang[a], Xiangrui Kong[a], Ying Sheng[a,*], Shuting Yang[a], Ruiqiao Yang[a], Xiaowei Zheng[a], Dazhen Yin[a], Penglei Du[a] and Jan Sundell[b]

[a]*Tianjin Key Laboratory of Indoor Air Environmental Quality Control, School of Environmental Science and Engineering, Tianjin University, Weijin Road 92, Nankai District, Tianjin, 300072, China*

[b]*School of Architecture, Tsinghua University, Haidian District, Beijing, 100084, China*

Abstract

In China, the prevalence rates of asthma and allergies have been increasing in past 50 years. Several epidemiological investigations have indicated that dampness is associated with health effects such as respiratory infections, asthma and allergy. This study aims to find the associations between home dampness and asthma, rhinitis and eczema among children. A cross-sectional study on dampness and asthma and allergy at Tianjin was launched in 2013. Questionnaires were used to survey indoor dampness and health outcomes of occupants. 3.5% parents reported that they have noticed visible mildew/mold in child's rooms. The association between water leakage and asthma among children was seemingly strong (AOR: 3.29, 95% CI: 1.75-6.19). The dampness in home may have influence on asthma, rhinitis and eczema among children.

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* Corresponding author. Tel.: +86-022-2366-0833; fax: +86-022-2789-0131.
E-mail address: ysheng@tju.edu.cn

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1. Introduction

In China, the prevalence of asthma and allergies has been increasing in recent years [1]. Bornehag et al. [2] found that dampness in buildings has been associated to health problems like asthma and respiratory symptoms all over the world. In Sweden, a survey among 1-4 years children showed windowpane condensation tended to be most frequent in homes with children sensitized to cats or dogs [3]. Hägerhad-Engman et al. [4] found an association between moldy odors along skirting board and allergic symptoms, mainly rhinitis, among children, which indicated that hidden moisture problems in building structures should not be ignored. In a Taiwanese study, the adjusted odds ratios of stuffy odor for allergic rhinitis was 1.37 (95% CI: 1.03-1.83) and water leakage for cough was 5.74 (95% CI: 2.20-14.95) [5].

This study is part of the China, Children, Homes, Health (CCHH) study which aims to investigate the association between home environment (such as dampness, allergens, VOCs and SVOCs) and asthma, rhinitis and eczema among children.

2. Methods

This Tianjin CCHH study consisted of two phases, i.e., Phase I a cross-sectional study and Phase II a case-control study. In Phase I, parents of children 0-8 years old participated in a questionnaire survey and reported indoor dampness and children's health outcomes. Indoor dampness included visible mold/mildew, damp stains, suspected moisture problem, water leakage and condensation on the inner windowpane in winter. Health outcomes of children were allergic symptoms in the last 12 months, and diagnosed asthma, rhinitis, eczema.

All statistical analyses were performed with SPSS 20.0 software. Chi-square test and logistic regression model were used to analyze the association between the home dampness and occupants' health. A P value less than 0.05 indicates a statistically significance.

3. Results

In total, parents of 7570 children responded to the survey. Table 1 shows the demographic information of these children and their health outcomes.

Table 1. Demographic information and health outcomes of 7570 children aged 0-8 years old in Tianjin, China

		Questionnaire (n=7570)	
		n	%
Age	<3	225	3.1
	3-6	4994	67.8
	7-8	2147	29.1
Gender	Male	3822	51.9
	Female	3544	48.1
Family allergic history	Yes	968	14.0
Prevalence rate	Wheeze current	344	4.9
	Rhinitis current	2054	29.8
	Eczema current	1025	13.5
	Diag. asthma	313	4.1
	Diag. rhinitis	654	8.6
	Diag. eczema	2695	35.6

The percentage of dampness indices perceived in children's bedrooms is shown in Table2. 3.5% of homes had visible mildew/mold spots on wall, ceilings and floors, 5.6% had visible damp stains and 1.4% had water leakage in

child's room. Dry air was the most common complaint of perceived odors.

Table 2. The distribution of dampness indices in homes of children in Tianjin, China

	Questionnaire (n=7570)	
	n	%
Visible mildew/mold	242	3.5
Visible stains	377	5.6
Suspected moisture problems	1113	19.0
Water leakage	95	1.4
Condensation	1443	25.5
Moldy odor	900	13.3
Humid air	2167	31.8
Dry air	3661	53.2

Table 3 shows the association between dampness indices and health outcomes among children. Visible stains on wall, ceilings and floors, suspected dampness, water leakage, condensation and dry air had significantly effects on children's health such as wheeze, rhinitis and eczema in the last 12 months and diagnosed asthma, rhinitis and eczema.

The adjusted odds ratios of dampness problems for asthma and allergy are shown in Table 4. Dampness in homes were significant risk factors.

4. Discussion

In this study, the reported percentage of dampness problems of visible mold spots (3.5%), visible damp stains (5.6%) and water leakage (1.4%) was lower than the percentage of dampness problems (i.e., 12.2%-31.4%) in dorms of Tianjin[6] and those of 23-79% in a tropical monsoon climate, e.g. Taiwan [5].

Most studies had shown that moisture related problems are associated with respiratory health effects [2, 6, 7, 8]. This study confirmed the previous findings. In a Swedish study, visible dampness, as well as water leakage, condensation on windows showed a strongest association with asthma [9]. Jaakkola et al. [10] found in a Finnish population-based questionnaire study of children aged 1–6 years that visible mold, moisture, water leakage and moldy odor anywhere in the dwelling were all significantly associated with wheezing. However, Larsson et al. [11] found that self-reported moisture-related problems could be biased, since the baseline findings of a strong association between moisture-related problems and asthma decreased or disappeared in the follow-up study 5 years later in Sweden. This issue requires further studies.

5. Conclusions

Visible damp, suspected dampness, water leakage, condensation on window pane and dry air perception had significant effects on children's health such as allergic symptoms in the last 12 months and diagnosed asthma, rhinitis and eczema. In summary, dampness problems in homes may have negative effects on asthma, rhinitis and eczema among children.

Table 3. Effects of dampness indices on children's health in Tianjin, China

		Wheeze current		Rhinitis current		Eczema current		Diag. asthma		Diag. rhinitis		Dig. eczema	
		% (n)	P[a)]	% (n)	P[a)]	% (n)	P[a)]	% (n)	P[a)]	% (n)	P[a)]	% (n)	P[a)]
Visible mildew/mold	Yes	12.3 (27)	**0.00**	38.4(83)	**0.00**	19.7(44)	**0.04**	12.0(27)	**0.00**	14.7(32)	**0.01**	43.7(93)	0.20
	No	4.5 (282)		29.4(1846)		14.6(918)		4.3(272)		9.3(585)		39.3(2462)	
Visible stains	Yes	8.3 (29)	**0.00**	36.8(126)	**0.00**	20.1(70)	**0.00**	7.7(28)	**0.00**	13.5(47)	**0.01**	47.7(165)	**0.00**
	No	4.5 (269)		29.2(1759)		14.5(871)		4.3(260)		9.3(561)		39.1(2349)	
Suspected moisture problems	Yes	7.6 (79)	**0.00**	36.8(386)	**0.00**	20.2(214)	**0.00**	6.1(66)	**0.01**	11.9(126)	**0.00**	49.2(521)	**0.00**
	No	4.3 (192)		28.7(1271)		13.7(617)		4.3(193)		9.0(406)		37.3(1669)	
Water leakage	Yes	12.9(11)	**0.00**	46.3(38)	**0.00**	31.5(28)	**0.00**	15.6(14)	**0.00**	20.2(18)	**0.00**	56.8(50)	**0.00**
	No	4.6(287)		29.4(1845)		14.6(913)		4.3(275)		9.3(585)		39.3(2457)	
Condensation	Yes	7.0(96)	**0.00**	37.1(511)	**0.00**	16.8(232)	**0.03**	6.0(84)	**0.00**	11.2(156)	**0.02**	46.9(641)	**0.00**
	No	4.2(170)		27.6(1100)		14.3(570)		4.0(163)		9.0(360)		37.6(1502)	
Moldy odor	Yes	7.0(58)	**0.00**	34.1(282)	**0.00**	19.9(168)	**0.00**	5.4(46)	0.15	11.0(384)	**0.00**	44.8(1559)	**0.00**
	No	4.4(249)		28.6(1598)		13.9(775)		4.3(242)		7.5(227)		32.8(990)	
Humid air	Yes	4.9(100)	0.71	31.2(631)	**0.02**	17.5(355)	**0.00**	4.5(94)	0.83	10.3(211)	0.05	42.0(854)	**0.00**
	No	4.7(208)		28.5(1255)		13.5(592)		4.4(194)		8.8(385)		37.7(1655)	
Dry air	Yes	5.9(206)	**0.00**	34.5(1195)	**0.00**	17.8(617)	**0.00**	5.0(177)	**0.01**	11.5(97)	**0.02**	45.3(378)	**0.00**
	No	3.7(111)		24.0(726)		11.4(345)		3.8(115)		9.0(502)		38.0(2117)	

[a)] P value in Chi-square test.

Table 4. Odds ratios of dampness indices for health status among children (adjusted for gender, age, family allergic history) in Tianjin, China

	Wheeze current	Rhinitis current	Eczema current	Diag. asthma	Diag. rhinitis	Diag. eczema
Visible mildew/mold	**2.73(1.75,4.26)**	**1.35(1.00,1.81)**	1.26(0.88,1.80)	**2.82 (1.80,4.41)**	1.48(0.98,2.22)	1.09(0.81,1.46)
Visible stains	**1.94(1.29,2.93)**	**1.30(1.02,1.65)**	1.32(0.99,1.76)	**1.63(1.05,2.54)**	1.37(0.97,1.93)	**1.25(1.00,1.58)**
Suspected dampness	**1.64(1.22,2.19)**	**1.27(1.09,1.48)**	**1.39(1.16,1.67)**	1.23(0.90,1.67)	1.14(0.90,1.44)	**1.43(1.24,1.66)**
Water leakage	**2.46(1.23,4.91)**	**1.81(1.13,2.90)**	**2.40(1.47,3.90)**	**3.29(1.75,6.19)**	**1.96(1.10,3.49)**	1.55(0.98,2.46)
Condensation	**1.34(1.04,1.72)**	**1.46(1.30,1.65)**	1.11(0.95,1.30)	1.22(0.93,1.59)	1.12(0.92,1.36)	**1.29(1.15,1.45)**
Moldy odor	**1.61(1.19,2.20)**	**1.19(1.01,1.41)**	**1.46(1.20,1.78)**	1.06(0.74,1.51)	1.18(0.92,1.52)	**1.23(1.05,1.44)**
Humid air	1.06(0.82,1.36)	**1.13(1.00,1.28)**	**1.33(1.14,1.55)**	0.94(0.72,1.24)	1.17(0.97,1.42)	**1.16(1.04,1.30)**
Dry air	**1.46(1.13,1.85)**	**1.55(1.38,1.73)**	**1.55(1.38,1.73)**	1.15(0.89,1.50)	**1.34(1.11,1.61)**	**1.57(1.41,1.75)**

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References

[1] National Cooperation Group on Childhood Asthma, A nationwide survey in China on prevalence of asthma in urban children (in Chinese), Chin J Pediatr. 41 (2003) 123-127.
[2] C.G. Bornehag, G. Blomquist, F. Gyntelberg, B. Järvholm, P. Malmberg, L. Nordvall, A. Nielsen, G. Pershagen, J. Sundell, Dampness in buildings and health, Indoor Air. 11 (2001) 72-86.
[3] A. Lindfors, M. Wickman, G. Hedlin, G. Pershagen, H. Rietz, S.L. Nordvall, Indoor environmental risk actors in young asthmatics: a case-control study, Arch. Dis. Child. 73 (1995) 408-412.
[4] L. Hägerhad-Engman, T. Sigsgaard, I. Samuelson, J. Sundell, S. Janson, C.G. Bornehag, Low home ventilation rate in combination with moldy odor from the building structure increase the risk for allergic symptoms in children, Indoor Air. 19 (2009) 184-192.
[5] C.S. Li, L.Y. Hsu, Home dampness and childhood respiratory symptoms in a subtropical climate, Arch Environ Health. 51 (1996) 42-46.
[6] Y. Sun, Y. Zhang, J. Sundell, Z. Fan, L. Bao. Dampness at dorm and its associations with allergy and airways infection among college students in China: a cross-sectional study, Indoor Air. 19 (2009) 174-182.
[7] N. Aberg, J. Sundell, B. Eriksson, B. Hesselmar, B. Aberg, Prevalence of allergic diseases in school children in relation to family history, upper respiratory infections, and residential characteristics, Allergy. 51 (1996) 232-237.
[8] M. Simoni, E. Lombardi, G. Berti, F. Rusconi, S. La Grutta, S. Piffer, M.G. Petronio, C. Galassi, F. Forastiere, G. Viegi, Mould/dampness exposure at home is associated with respiratory disorders in Italian children and adolescents: The SIDRIA-2 Study, Occupat Environ Med. 62 (2005) 616-622.
[9] C.G Bornehag, J. Sundell, L. Ha¨gerhed-Engman, T. Sigsggard, S. Janson, N. Aberg, 'Dampness' at home and its association with airway, nose, and skin symptoms among 10,851 preschool children in Sweden: A cross-sectional study, Indoor Air. 15 (2005) 48-55.
[10] J.J. Jaakkola, N. Jaakkola, R. Ruotsalainen, Home dampness and molds as determinants of respiratory symptoms and asthma in pre-school children. J Expo Anal Environ Epidemiol. 3 (1993) 129-142.
[11] M. Larsson, L. Hägerhed-Engman, S. Moniruzzaman, S. Janson, J. Sundell, C.G. Bornehag, Can we trust cross-sectional studies when studying the risk of moisture-related problems indoor for asthma in children? International Journal of Environmental Health Research. 21 (2011) 237-247.